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(54) **Thin film structure having magnetic and colour shifting properties**

Struktur aus dünnen Schichten mit magnetischen und farbverändernden Eigenschaften

Structure de couches minces ayant de propriétés magnétiques et de modification de couleur

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## Description

[0001] This invention relates to a thin film structure having magnetic and optically variable characteristics and more particularly to a magnetic optically variable pigment and device.

[0002] Optical variable articles having substantial color shift with angle have been disclosed in US-A-4,705,356 and US-A-4,705,300. However, it has been found when such an article is utilized in security applications as well as in anticounterfeit applications there is a need for additional security. This is true in both pigment and device applications.

[0003] EP-A-170832 discloses a thin film structure in which a magnetic layer is embossed into a diffraction grating structure.

[0004] In general, it is an object of the present invention to provide a thin film structure having both magnetic and optically variable characteristics.

[0005] Another object of the invention is to provide a pigment and device of the above character which can be readily manufactured.

[0006] This invention provides a thin film structure having optically variable properties providing substantial colour shift with angle of incidence and viewing comprising a substrate and a multilayer thin film metal-dielectric interference coating including a metal absorber layer, a dielectric spacer layer, and a reflective metallic layer carried by the substrate to produce said inherent colour shift with angle, said reflective metallic layer forming an integral part of the multilayer thin film metal-dielectric interference coating to contribute to the optically variable properties to provide one anticounterfeiting feature; wherein said reflective metallic layer carried directly by the substrate is formed from a material which has magnetic as well as reflective properties to provide another anticounterfeiting feature.

[0007] The invention also provides a structure having optically variable properties providing substantial colour shift with angle of incidence and viewing comprising a substrate and a symmetrical multilayer interference coating carried by the substrate having a metallic layer (2) formed of a metallic material which is highly reflecting, dielectric spacer layers disposed on opposite sides of the reflective metallic layer and metallic absorber layers disposed on each of the dielectric spacer layers, the reflective metallic layer forming an integral part of the symmetrical multilayer interference coating to contribute to the optically variable properties which provide one anticounterfeiting feature; wherein the reflective metallic layer is formed from a material which has magnetic as well as reflective properties to provide another anticounterfeiting feature.

[0008] The following is a description of a number of preferred embodiments of the invention which are set forth in detail in conjunction with the following drawings:

[0009] Figure 1 is a cross sectional view of a magnetic color shifting optical variable device incorporating the

present invention.

[0010] Figure 2 is a cross sectional view of a magnetically optically variable pigment incorporating the present invention.

[0011] Figure 3 is a cross sectional view of a device which is transferable.

[0012] In general, the thin film structure having magnetic and optically variable properties consists of a multilayer interference coating which produces an inherent color shift with angle. The interference coating has a metal-dielectric design. The metal utilized in the design has magnetic properties to permit recording of information magnetically in the metal. When it is desired to produce a specific color shift in reflection from one color to another by removing certain colors, or to modify the color shift properties, a subtractive colored superstrate is provided external of the multilayer interference coating on the side of the multilayer interference coating facing the incident light. The colored superstrate (also called a subtractive colorant means) in combination with a multilayer interference coating serves to modify the inherent color shift produced by the multilayer interference coating. This combination of a subtractive colorant means and the multilayer interference coating provides a discrete color shift from one distinct color to another at two different angles of incidence, and/or modifies the colors produced by the interference coating.

[0013] More particularly, as shown in Figure 1, a thin film structure is in the form of a magnetic color shifting optically variable device 11. As shown therein, it consists of a substrate 12 which can be formed of a suitable material such as PET or other suitable material as set forth in U.S. Patent No. 4,705,356. The substrate 12 is provided with first and second surfaces 13 and 14. A multilayer interference coating 16 is provided on the first surface 13. As described in U.S. Patent No. 4,705,356, the multilayer interference coating 16 has a metal-dielectric design which consists of a periodic structure of alternating metal and dielectric layers on a relatively high reflecting opaque metal layer 17.

[0014] As explained in U.S. Patent No. 4,705,356, the metal dielectric design in its simplest form can be a three layer combination such as shown in Figure 1. In such a design, the first metal layer 17 is preferably a highly reflecting metal layer. In accordance with the present invention rather than using a highly reflective non-magnetic metal layer such as aluminum, the metal is chosen so that in addition to having high reflecting properties it also has magnetic qualities for a purpose hereinafter described. One metal found to be particularly suitable for this application is a cobalt nickel alloy with a ratio by weight of 80% cobalt and 20% nickel plus or minus 10% for each metal. Such a metal layer is deposited on the surface 13 to a thickness so that it is substantially opaque. An optical spacer layer 18 in the form of a suitable dielectric (i.e., having a low index of refraction) such as magnesium fluoride is deposited on the cobalt nickel layer 17. A metal with high absorption properties

is then deposited on the dielectric layer 18 to provide an absorber layer 19. One metal found to be suitable for this is chromium. Other metals which have such high absorption characteristics can be selected in the manner suggested in U.S. Patent No. 4,705,356.

[0015] It should be appreciated that the basic reflectance profile for the three-layer metal-dielectric design for the interference filter 16 would be essentially retained in designs employing additional periods of the thin metal and dielectric. The multilayer interference coating 16 provide an inherent color shift with the change in viewing angle. In Figure 1, the incident light is indicated by ray 21a or ray 21b and the reflected light is indicated by ray 22a or 22b as viewed by the eye 23a or 23b. At the eye position of 23a one sees one color, Color A, and at position 23b another color, Color B.

[0016] When it is desired to produce a specific color shift or to eliminate certain colors, subtractive colorant means is provided external of the multilayer interference coating on the side of the multilayer interference coating 16 facing the incident light. This subtractive colorant means in combination with a multilayer interference coating serves to modify the inherent color shift produced by the multilayer interference coating to provide a discrete color shift from one distinct color to another distinct color at two different angles of incidence. This subtractive colorant means can take the form of a dyed superstrate 26 as shown in Figure 1. The dyed superstrate 26 must be optically thick and have a minimum thickness in the range of about 1.5 to 2.0 microns.

[0017] The optical variable device or structure shown in Figure 1 can be utilized in the manner described in U. S. Patent No. 4,705,356. In addition, it can be utilized to encode information in the magnetic layer 17. For example, it could record the typical information which is carried by a credit card in a magnetic stripe. It also could be utilized for putting the numbers on the bottoms of checks so that the information carried by the check could be read magnetically as with present day checks and still provide the optical variable feature.

[0018] It also should be appreciated that the present invention can be incorporated in a magnetic and optically variable ink by providing flakes in the manner described in EP - A - 0227423.

[0019] It should be appreciated that if desired in place of the chromium absorber layer, the absorber layer also could be formed of the cobalt nickel alloy. This simplifies the manufacture of the magnetic optically variable device or structure by only using a single metal and a single dielectric.

[0020] Another embodiment of the thin film structure having magnetic and optical variable properties is shown in Figure 2 and takes the form of a magnetic optically variable pigment. As shown in Figure 2, this pigment is comprised of a symmetrical design which lends itself to being broken up into flakes which can be utilized in making pigment in the manner described in EP - A - 0227423. The symmetrical design 31 shown in Figure 2

is formed using a reflecting metallic layer which also has magnetic properties. As explained in connection with the previous embodiment, the metal is selected for its reflecting properties as well as its magnetic properties.

5 The metal is deposited to a thickness so that it is substantially opaque. One metal found to be satisfactory is a cobalt nickel alloy with the cobalt nickel having a ratio by weight of 80% and 20% respectively. This ratio for each of the metals can be varied by plus or minus 10% and still achieve the desired results. The reflecting layer 10 32 is provided with first and second reflecting surfaces 33 and 34. Dielectric spacer layers 36 and 37 are provided on the surfaces 33 and 34 and are formed of a suitable low index of refraction material such as magnesium fluoride. Metallic absorber layers 38 and 39 formed of a suitable absorber metal such as chromium are deposited on the dielectric layers 36 and 37. They are deposited to a thickness so that they are semi-transparent. As pointed out previously, when it is desired to use only a single metal in the structure, the chromium layer can be replaced with the cobalt nickel alloy utilized for the reflecting layer 32.

[0021] If a specific color shift is desired or if it is desired to remove certain colors, dyed superstrates 41 and 42 are provided on the metal layers 38 and 39 to provide subtractant colorant means of the type hereinbefore described in connection with Figure 1.

[0022] The structure which is shown in Figure 2 can be prepared in flake form in the manner described in EP - A - 0227423. The symmetrical design particularly lends itself to such an application. In utilizing flakes formed from the structure shown in Figure 2, a magnetic optically variable pigment can be provided in which magnetic information can be encoded in the paint incorporating the pigment or in which the pigment simply exhibits its magnetic properties so that it can be utilized in credit cards, checks and the like in the manner hereinbefore described.

[0023] An alternate construction is shown in Figure 3 which is transferrable and generally comprises a metal dielectric thin film stack which can be provided with or without a subtractive colorant placed on a releasable hardcoat substrate which can be transferred to another substrate. This device 46 as shown in Figure 3 consists of a transparent flexible substrate formed of a suitable material such as PET. The substrate 47 is provided with surfaces 48 and 49. A releasable hardcoat or releasable layer 51 is deposited on the surface 48 and is of a conventional type. The release layer 51 can be formed of any suitable material such as a wax, silicone or acrylic and can have a suitable thickness such as approximately 1 micron. If desired, the releasable material should be one which can carry a color so that a dyed releasable hardcoat can be provided when that effect is desired. When the release layer is dyed it provides the subtractive colorant means in the dyed superstrates in the previous embodiments of the present invention.

[0024] A metallic layer 52 is deposited on the release

layer 51 and is formed of a suitable material such as chromium. This metallic layer serves as one of the metal layers in the metal dielectric stack. The dielectric is formed by a layer 53 formed of a suitable dielectric having a low index of refraction as, for example, magnesium fluoride. Another metal layer 54 formed of a cobalt nickel composition of the type hereinbefore described as, for example, an 80-20% by weight mixture is disposed on the dielectric layer 53. An adhesive layer 56 is deposited on the metal layer 54. The adhesive can be a conventional hot stamp adhesive or other suitable type of adhesive such as a pressure sensitive adhesive. The adhesive layer 56 can have a suitable thickness such as approximately 1/2 mil (12.7  $\mu\text{m}$ ). The metal dielectric stack which is shown in Figure 3 can be readily transferred to another article.

[0025] When it is desired to make a transfer, a hot die stamp can be utilized to stamp out the desired image and to heat the adhesive so that the adhesive will adhere to the transfer substrate at the places where it is heated. Thus the device of the present invention will only be transferred in the areas where heat has been applied.

[0026] It should be appreciated that with a device such as shown in Figure 3, it is possible to place the adhesive on the counter surface in predetermined locations. A roll-on transfer can then be utilized which will cause the device to stick where the adhesive is present and not to stick where the adhesive is not present so that a pattern can be provided if the device is provided on the counter surface.

[0027] It should be appreciated that in accordance with the present invention, the structure or device can be placed in a bar code pattern which would produce an optically variable bar code device that would appear on a label or on the article itself. Such a bar code would function as an optically variable bar code that could be read by both optical and magnetic readers. Such a bar code optically variable device would provide three security features, the bar code itself, the optically variable characteristic and the magnetic characteristic.

[0028] From the foregoing it can be seen that there has been provided a thin film structure which has both magnetic and optically variable properties which lend itself to many different types of applications, particularly where additional security is desired.

#### Claims

1. A thin film structure having optically variable properties providing substantial colour shift with angle of incidence and viewing comprising a substrate (12) and a multilayer thin film metal-dielectric interference coating (16) including a metal absorber layer (19), a dielectric spacer layer (18), and a reflective metallic layer (17) carried by the substrate to produce said inherent colour shift with angle, said reflective metallic layer (17) forming an integral part

of the multilayer thin film metal-dielectric interference coating (16) to contribute to the optically variable properties to provide one anticounterfeiting feature; characterised in that said reflective metallic layer (17) carried directly by the substrate is formed from a material which has magnetic as well as reflective properties to provide another anticounterfeiting feature.

2. A structure as claimed in claim 1, characterised in that said metallic layer (17) having reflecting and magnetic properties is a cobalt nickel alloy.
3. A structure as claimed in claim 2, characterised in that said cobalt nickel alloy (17) is a composition of 80% cobalt and 20% nickel by weight plus or minus 10% for each metal in the alloy.
4. A structure as claimed in any of claims 1 to 3, characterised in that a subtractive colourant means (26) is provided external of the multilayer interference coating (16) on the side of the multilayer interference coating (16) facing the incident light, said subtractive colourant means (26) in combination with the multilayer interference coating (16) serving to modify the inherent colour shift produced by the multilayer interference coating (16) to provide a discrete colour shift from one distinct colour to another colour at two different angles of incidence.
5. A structure as claimed in claim characterised in that said subtractive colourant means (26) is in the form of a dyed superstrate (26).
6. A thin film structure having optically variable properties providing substantial colour shift with angle of incidence and viewing comprising a substrate and a symmetrical multilayer interference coating carried by the substrate having a metallic layer (32) formed of a metallic material which is highly reflecting, dielectric spacer layers (36, 37) disposed on opposite sides of the reflective metallic layer and metallic absorber layers (38, 39) disposed on each of the dielectric spacer layers, the reflective metallic layer forming an integral part of the symmetrical multilayer interference coating to contribute to the optically variable properties which provide one anticounterfeiting feature; characterised in that the reflective metallic layer (32) is formed from a material which has magnetic as well as reflective properties to provide another anticounterfeiting feature.
7. A thin film structure as claimed in claim 6, characterised in that a subtractive colourant means (41, 42) is carried by each of the opposite sides of the symmetrical multilayer interference coating.
8. A thin film structure as claimed in claim 6 or claim

7, incorporated in an ink.

9. A thin film structure as claimed in claim 6 or claim 7, is incorporated in a paint.

#### Patentansprüche

1. Dünnschichtkörper mit optisch veränderlichen Eigenschaften, wobei es je nach dem Einfallswinkel und Sichtwinkel zu einer starken Farbverschiebung kommt und wobei der Dünnschichtkörper ein Substrat (12) und eine mehrschichtige Metall-Dielektrikum-Dünnschicht-Interferenzbeschichtung (16) umfaßt, die eine Absorberschicht (19), eine dielektrische Zwischenschicht (18) und eine dem Substrat aufliegende reflektierende Metallschicht (17) enthält, um die dem Schichtkörper eigene vom Winkel abhängige Farbverschiebung zu erzeugen, wobei die reflektierende Metallschicht (17) einen integrierenden Bestandteil der mehrschichtigen Metall-Dielektrikum-Dünnschicht-Interferenzbeschichtung (16) bildet, um auf diese Weise zu den optisch veränderlichen Eigenschaften beizutragen und so ein fälschungssicheres Merkmal zu bilden, dadurch **gekennzeichnet**, daß die unmittelbar dem Substrat aufliegende reflektierende Metallschicht (17) aus einem Material gebildet ist, das sowohl magnetische als auch reflektierende Eigenschaften aufweist, um so ein weiteres fälschungssicheres Merkmal zu bilden.
2. Schichtkörper nach Anspruch 1, dadurch **gekennzeichnet**, daß die reflektierende und magnetische Eigenschaften aufweisende Metallschicht (17) eine Kobalt-Nickel-Legierung ist.
3. Schichtkörper nach Anspruch 2, dadurch **gekennzeichnet**, daß die Kobalt-Nickel-Legierung (17) aus  $80 \pm 10$  Gew.% Kobalt und  $20 \pm 10$  Gew.% Nickel besteht.
4. Schichtkörper nach einem der Ansprüche 1 bis 3, dadurch **gekennzeichnet**, daß außen an der mehrschichtigen Interferenzbeschichtung (16) auf ihrer dem einfallenden Licht ausgesetzten Außenfläche ein subtraktives Färbemittel (26) vorgesehen wird, das in Verbindung mit der mehrschichtigen Interferenzbeschichtung (16) der Modifizierung der inhärenten, von der mehrschichtigen Interferenzbeschichtung (16) erzeugten Farbverschiebung von einer bestimmten Farbe zu einer anderen bestimmten Farbe bei zwei unterschiedlichen Einfallswinkeln dient.
5. Schichtkörper nach Anspruch 4, dadurch **gekennzeichnet**, daß das subtraktive Färbemittel (26) in Form eines gefärbten Substrats (26) vorliegt.

6. Dünnschichtkörper mit optisch veränderlichen Eigenschaften, wobei es je nach dem Einfallswinkel und Sichtwinkel zu einer starken Farbverschiebung, der ein Substrat und eine dem Substrat aufliegende symmetrische mehrschichtige Interferenzbeschichtung umfaßt, die eine aus einem stark reflektierenden metallischen Stoff gebildete Metallschicht (32) und auf den gegenüberliegenden Seiten der Metallschicht angeordnete dielektrische Zwischenschichten (36, 37) und auf jeder der dielektrischen Zwischenschichten angeordnete metallische absorbierende Schichten (38, 39) aufweist, wobei die reflektierende Metallschicht einen integrierenden Bestandteil der symmetrischen mehrschichtigen Interferenzbeschichtung bildet, um auf diese Weise zu den optisch veränderlichen Eigenschaften beizutragen, die ein fälschungssicheres Merkmal bereitstellen, dadurch **gekennzeichnet**, daß die reflektierende Metallschicht (32) aus einem Material gebildet ist, das sowohl magnetische als auch reflektierende Eigenschaften aufweist, um so ein weiteres fälschungssicheres Merkmal zu bilden.
7. Dünnschichtkörper nach Anspruch 6, dadurch **gekennzeichnet**, daß jede der gegenüberliegenden Seiten der symmetrischen mehrschichtigen Interferenzbeschichtung ein subtraktives Färbemittel (41, 42) trägt.
8. Dünnschichtkörper nach einem der Ansprüche 6 oder 7, der in eine Druckfarbe eingearbeitet ist.
9. Dünnschichtkörper nach einem der Ansprüche 6 oder 7, der in eine Anstrichfarbe eingearbeitet ist.

#### Revendications

1. Structure en pellicule mince ayant des propriétés optiquement variables produisant un décalage important de couleur suivant l'angle d'incidence et d'observation, comportant un substrat (12) et un revêtement d'interférence métal-isolant (16) en pellicule mince multicouche comprenant une couche métallique absorbante (19), une couche isolante d'écartement (18) et une couche métallique réfléchissante (17) portées par le substrat pour produire ledit décalage inhérent de couleur avec l'angle, ladite couche métallique réfléchissante (17) formant partie intégrante du revêtement d'interférence métal-isolant (16) en pellicule mince multicouche afin de contribuer aux propriétés optiquement variables pour produire une caractéristique interdisant les contrefaçons ; caractérisée en ce que ladite couche métallique réfléchissante (17) portée directement par le substrat est formée d'une matière qui possède des propriétés magnétiques ainsi que réfléchissantes pour procurer une autre caractéristique in-

terdisant les contrefaçons.

2. Structure selon la revendication 1, caractérisée en ce que ladite couche métallique (17) ayant des propriétés réfléchissantes et magnétiques est un alliage de cobalt et de nickel. 5
3. Structure selon la revendication 2, caractérisée en ce que ledit alliage de cobalt et de nickel (17) est une composition de 80% de cobalt et de 20% de nickel en poids, plus ou moins 10% de chaque métal dans l'alliage. 10
4. Structure selon l'une quelconque des revendications 1 à 3, caractérisée en ce qu'un moyen colorant soustractif (26) est placé à l'extérieur du revêtement d'interférence multicouche (16) sur la face du revêtement d'interférence multicouche (16) qui est tournée vers la lumière incidente, ledit moyen colorant soustractif (26), en combinaison avec le revêtement d'interférence multicouche (16), sert à modifier le décalage inhérent de couleur produit par le revêtement d'interférence multicouche (16) pour produire un décalage discret de couleur d'une couleur distincte à une autre couleur sous deux angles différents d'incidence. 15  
20  
25
5. Structure selon la revendication 4, caractérisée en ce que le moyen colorant soustractif (26) a la forme d'une couche extérieure teintée (26). 30
6. Structure en pellicule mince ayant des propriétés optiquement variables produisant un décalage important de couleur suivant l'angle d'incidence et d'observation, comportant un substrat et un revêtement symétrique d'interférence multicouche porté par le substrat ayant une couche métallique (32) formée sur une matière métallique qui est hautement réfléchissante, des couches isolantes (36,37) d'écartement disposées sur des faces opposées de la couche métallique réfléchissante et des couches métalliques absorbantes (38,39) disposées sur chacune des couches isolantes d'écartement, la couche métallique réfléchissante formant partie intégrante du revêtement symétrique d'interférence multicouche pour contribuer aux propriétés optiquement variables qui procurent une caractéristique interdisant les contrefaçons ; caractérisée en ce que la couche métallique réfléchissante (32) est formée d'une matière qui possède des propriétés magnétiques ainsi que réfléchissantes pour procurer une autre caractéristique interdisant les contrefaçons. 35  
40  
45  
50
7. Structure en pellicule mince selon la revendication 6, caractérisée en ce qu'un moyen colorant soustractif (41,42) est porté par chacune des faces opposées du revêtement symétrique d'interférence 55

multicouche.

8. Structure en pellicule mince selon la revendication 6 ou la revendication 7, incorporée dans une encre.
9. Structure en pellicule mince selon la revendication 6 ou la revendication 7, incorporée dans une peinture.

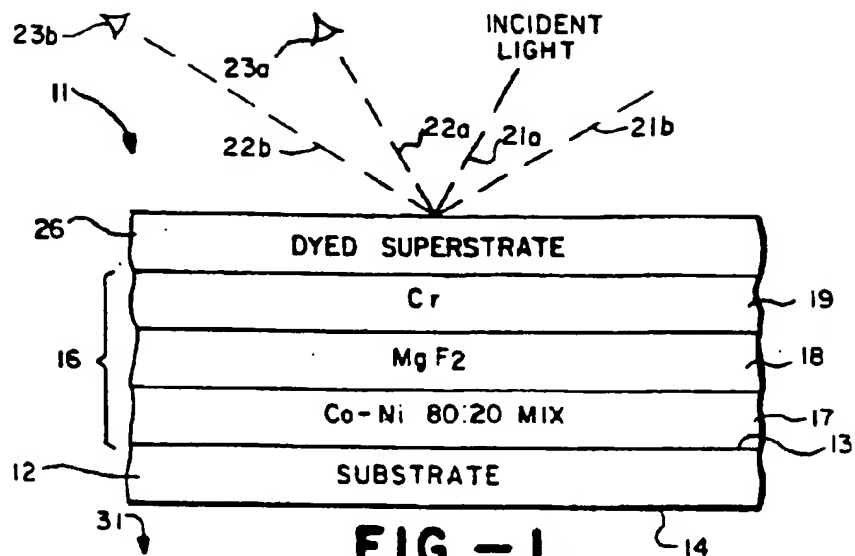


FIG. -1

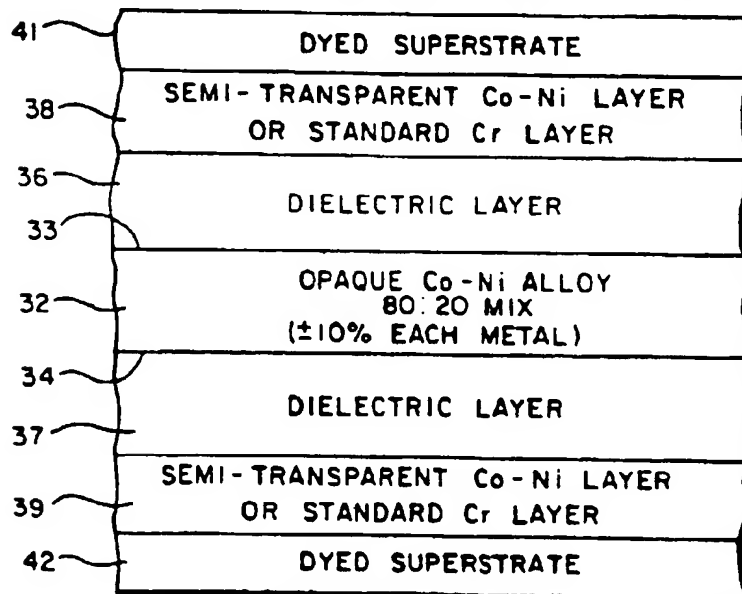


FIG. -2

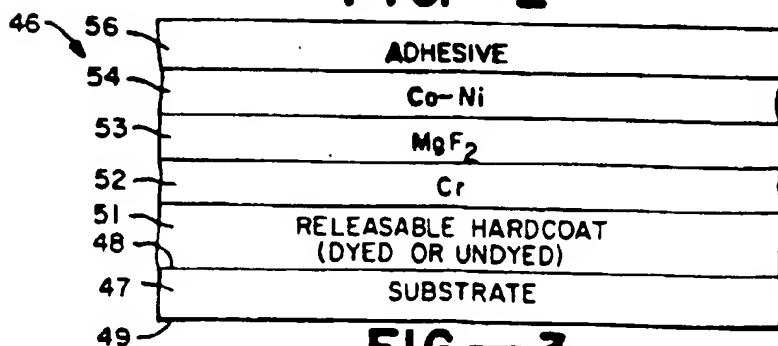


FIG. -3